American Dietetic Association

RESEARCH

Perspectives in Practice

White Rice Sold in Hawaii, Guam, and Saipan Often Lacks Nutrient Enrichment

RACHAEL T. LEON GUERRERO, PhD, RD; SUSAN E. GEBHARDT, MS; JOANNE HOLDEN, MS; MARY J. KRETSCH, PhD, RD; KAREN TODD, MS, RD; RACHEL NOVOTNY, PhD, RD; SUZANNE P. MURPHY, PhD, RD

ABSTRACT

Rice is a commonly consumed food staple for many Asian and Pacific cultures thus, nutrient enrichment of rice has the potential to increase nutrient intakes for these populations. The objective of this study was to determine the levels of enrichment nutrients (ie, thiamin, niacin, iron, and folic acid) in white rice found in Guam, Saipan (Commonwealth of the Northern Mariana Islands), and Oahu (Hawaii). The proportion of white rice that was labeled "enriched" varied by type, bag size, and location. Most long-grain rice was labeled as enriched and most medium-grain rice was not. Bags of either type weighing >10 lb were seldom labeled as enriched in Hawaii or Saipan. Samples of various types of rice were collected on these three islands (n=19; 12 of which were labeled as enriched) and analyzed for their content of enrichment nutrients. Rice that was labeled as enriched in Hawaii and Guam seldom met the minimum enrichment standards for the United States. For comparison, three samples of enriched rice from California were also analyzed, and all met the enrichment standards. Food and nutrition professionals who are planning or evaluating diets of these Pacific island populations cannot assume that rice is enriched.

J Am Diet Assoc. 2009;109:1738-1743.

R. T. Leon Guerrero is professor, College of Natural and Applied Sciences, University of Guam, Mangilao, Guam. S. E. Gebhardt is nutritionist and J. Holden is research leader, Nutrient Data Laboratory, Beltsville Human Nutrition Research Center, US Department of Agriculture, Beltsville, MD. M. J. Kretsch is deputy administrator, Nutrition, Food Safety/Quality Program, Agricultural Research Service, US Department of Agriculture, Beltsville, MD. K. Todd is retired; at the time of the study, she was nutrition manager, General Clinical Research Center, University of California, San Francisco. R. Novotny is professor, Department of Human Nutrition, Food, and Animal Sciences, University of Hawaii, Honolulu. S. P. Murphy is research (professor), Cancer Research Center of Hawaii, Honolulu.

Address correspondence to: Rachael T. Leon Guerrero, PhD, RD, College of Natural and Applied Sciences, University of Guam, UOG Station, Mangilao, Guam 96923. E-mail: rachaeltlg@uguam.uog.edu

Manuscript accepted: April 13, 2009.

0002-8223/09/10910-0007$36.00/0
doi: 10.1016/j.jada.2009.07.008

Rice is a primary staple food for many Asian and Pacific cultures, including those of Hawaii, Guam (a US Territory in the Pacific), and Saipan (an island within the US Commonwealth of the Northern Mariana Islands). In the United States and associated jurisdictions, such as Guam and the Commonwealth of the Northern Mariana Islands, commonly consumed refined grains such as white rice are often enriched with the nutrients thiamin, niacin, iron, and folic acid in order to increase intakes of these nutrients. Although enrichment is not mandatory (1), the US Food and Drug Administration requires packages of rice that are labeled "enriched" to contain at least the minimum level of enrichment for these nutrients as specified in the Code of Federal Regulations (2). The current standard of identity for rice states that each pound of uncooked rice, if enriched, must contain 2 to 4 mg thiamin, 16 to 32 mg niacin, 13 to 26 mg iron, and 0.7 to 1.4 mg folic acid (21 Code of Federal Regulations Part: 137.350). The Federal Enrichment Standard for riboflavin in enriched rice has been stayed since 1958, and so riboflavin is not currently added to enriched rice (2).

Studies in Guam and Hawaii collected information on rice consumption by Chamorro, Filipino, Japanese-American, and native Hawaiian men and women (3,4). Rice contributes about 18% of the energy in the diets of Filipino and Japanese-American men and 11% to 14% of energy for Chamorro (indigenous people from Guam) and Hawaiian men. Intakes of rice by women in these ethnic groups are also high, ranging from 9% to 15% of energy. Enriched rice, therefore, has the potential to deliver substantial amounts of the four enrichment nutrients. For example, 200 g (1.25 cup) cooked enriched rice (an amount commonly consumed daily in these cultures) should contain approximately 22% of the Daily Value (5) for thiamin, 30% of the Daily Value for folate, and 15% of the Daily Value for niacin and for iron. Iron and folate are of particular public health importance in populations consuming diets that are energy-rich but nutrient-poor (6).

In the United States, the two methods used to enrich rice are coating and dusting (7-9). In the coating method, a fortificant liquid mix is sprayed on to the rice in several layers, forming a rice premix with a waxy layer that prevents micronutrient loss if the rice is washed before cooking. This premix is then blended with retail rice. In the dusting method, retail rice is dusted with the powder

Table 1. Description of the 22 white rice samples[a] collected from Hawaii, Guam, Saipan, and California and then analyzed for thiamin, niacin, folic acid, and iron enrichment

Sample ID	Purchase location	Type of rice	Enrichment on label	Weight of bag (lb)
A	Hawaii, supermarket	Sweet	Yes	5
B	Hawaii, supermarket	Medium grain	Yes	2
C	Hawaii, supermarket	Calrose	Yes	10
D	Guam, supermarket	Jasmine	Yes	50
E	Guam, supermarket	Calrose	Yes	20
F	Guam, supermarket	Jasmine	Yes	20
G	Guam, supermarket	Calrose	Yes	20
H	Guam, supermarket	Calrose (short)	Yes	10
I	Guam, supermarket	Calrose	Yes	10
J	Guam, supermarket	Medium grain	Yes	10
K	Hawaii, supermarket	Long grain	Yes	2
L	Saipan, supermarket	Long grain	Yes	3
M[b]	California, supermarket	Long grain	Yes	3
N	California, supermarket	Calrose	Yes	5
O[c]	California, supermarket	Long grain	Yes	2
P	Saipan, small market	Calrose	No	20
Q	Saipan, small market	Calrose	No	20
R	Hawaii, supermarket	Jasmine	No	5
S	Hawaii, supermarket	Calrose	No	25
T	Hawaii, supermarket	Calrose	No	20
U	Hawaii, supermarket	Calrose	No	20
V	Guam, supermarket	Jasmine	No	5

[a]Collected in January 2006 (samples A-J and P-V) and summer 2006 (samples K-O).
[b]Same brand as sample L.
[c]Same brand as sample K.

form of a micronutrient premix. The assumption is that the micronutrient powder will stick to the rice grain surface because of electrostatic forces. Consumers are advised that rice enriched by dusting should not be rinsed before or after cooking because the enrichment nutrients will be lost (7).

Because washing rice before cooking is a common practice in the Pacific region, the impact of washing on the enrichment nutrients was initially investigated. Samples from one package of enriched rice from Guam were prepared in three ways: according to the label directions (unwashed); washed twice in local tap water; and "superwashed," that is, rubbed between the hands in tap water, as is the local custom. When laboratory analyses demonstrated no difference in the nutrient composition of washed and unwashed rice samples, the study was modified with the objective of determining the actual levels of enrichment nutrients in white rice in Guam, Oahu (Hawaii), and Saipan.

METHODS

Rice Sampling from Stores

Staff in Hawaii (Cancer Research Center of Hawaii), Guam (University of Guam), and Saipan (Northern Marianas College) visited a variety of retail stores to collect information on the availability as well as relative proportion of enriched and unenriched white rice on the shelves. For each product, the brand name, rice type, and weight of the bag were recorded. Although stores were not chosen at random, an effort was made to include small and large markets, ethnic markets, and large discount stores (on Guam and Hawaii). The survey included eight stores in Saipan, five stores in Honolulu, Hawaii, and seven stores in Guam.

A variety of types of rice were collected for analysis, including long-grain, medium-grain, jasmine, and Calrose (a type of medium-grain rice originally developed in California). Rice was purchased in the three island locations in January 2006. Types of rice to be analyzed were chosen based on the most common brands and sizes of rice packages available. Seventeen rice bags were collected: eight in Guam (seven labeled as enriched, one unenriched), seven in Honolulu (three enriched, four unenriched), and two in Saipan (both unenriched). Bags were purchased from more than one store location on each island (two each in Guam and Saipan, and three in Honolulu). Whenever possible, rice bags were purchased as 20-lb or 50-lb units because the typical family in these areas purchases rice in bulk.

Approximately 6 months later, five additional rice bags were collected to provide additional information. A bag of long-grain enriched rice was collected in Hawaii because no long-grain bags were included in the initial collection. An enriched rice bag was collected in Saipan because the initial collection included only unenriched bags from Saipan. Finally, for comparison, three enriched rice bags were collected from a single supermarket in northern California. Table 1 lists the purchase location, rice type, enrichment status, and bag weight of the 22 rice samples that were analyzed. Samples A through O were labeled as enriched, and samples P through V were not.

Sample Preparation

Each purchased rice bag was emptied into a large container and stirred so that all contents were distributed uniformly. A 3-lb portion from each bag was weighed and packed into an airtight container and shipped by express mail to the Food Analysis Laboratory Control Center at Virginia Polytechnic Institute and State University for preparation. Virginia Polytechnic Institute and State University is a collaborator with the Agricultural Research Service of the US Department of Agriculture for the National Food and Nutrient Analysis Program (10).

Once at Virginia Polytechnic Institute and State University, 450-g samples were taken after the entire 3-lb portion was stirred again. These samples were ground in 150-g batches in a Girmi model TR 30 mill (Girmi, Brescia, Italy). Ground samples were dispensed into 1-oz glass sample jars with Teflon-lined screw caps, capped under nitrogen, and stored at −60°C.

Analytical Methods

The samples, along with the appropriate control and reference materials (11), were shipped on dry ice to analytical laboratories that have been prequalified to perform nutrient analyses through the National Food and Nutrient Analysis Program. Thiamin was analyzed by a fluorometric method, Association of Official Analytical Chemists (AOAC) 942.23 (12). Niacin analyses used a microbiological assay, AOAC 944.13, 940.46 and 985.34. Iron was analyzed by inductively coupled plasma atomic emission spectrometry, using AOAC 985.01 and 984.27, Metals in Food by inductively coupled plasma, while folic acid levels were determined by liquid chromatography mass spectrometry using a trienyzme extraction and methods modified from Doherty and Beecher (13) and Kok and colleagues (14). Because of cost constraints, folic acid content was determined in a subset of five samples, A, E, G, I, and J (Table 1) that contained relatively high amounts of the other enrichment nutrients. Moisture was analyzed by a gravimetric method, AOAC 964.22.

Control Samples for Nutrient Analyses

Reference materials were obtained from the National Institute of Standards and Technology (Gaithersburg, MD) and the American Association of Cereal Chemists (St Paul, MN), quality-control materials were prepared by Virginia Polytechnic Institute and State University. Because reference materials were included as quality control in each batch of nutrient analyses, duplicate analyses were not performed.

Additional Evaluation of Enrichment Distribution

To further investigate the low levels of enrichment nutrients in many of the samples, two additional evaluations were conducted. To ensure that the low values were not a result of inadequate mixing of the rice, enrichment nutrients were analyzed in three samples from a single bag: sample L from Saipan. There was little variation across the samples: thiamin ranged from 1.21 to 1.47 mg/100 g, niacin ranged from 5.87 to 6.68 mg/100 g, and iron ranged from 3.30 to 3.98 mg/100 g (in percentages, these differences are 16.5%, 13.8%, and 20.6% of the lowest value). Although sample L exceeded the minimum enrichment standards for these nutrients, it was reassuring to note the relatively low within-bag variability.

The second evaluation involved an examination of iron remaining in the rice packaging after the rice had been removed. There was concern that if the "coating" method for enrichment was used, the spraying process might result in a coating of enrichment that could flake off during shipment and storage. Iron was chosen as an indicator of enrichment nutrients remaining on or in the packaging. Four new samples of rice were collected from a supermarket in Maryland. Three were long-grain, one was Calrose, and all were labeled as enriched. Three of the bags were plastic and one was a coated paper. The packaging was rinsed several times in a dilute hydrochloric acid (HCl) solution (0.6 mol/L), and then the HCl rinse was analyzed for iron. Only trace amount of iron were found in the HCl solution, ranging from 0.002 mg iron for a 1-lb bag, to 0.031 mg iron for a 5-lb bag, which was also the paper bag and may have contained small amounts of iron leached from the paper. For comparison, the rice granules were also rinsed in the HCl solution to ensure that the rice was enriched with iron. The iron levels in this HCl solution were found to be 8 to 250 times higher than iron levels detected in the HCl solution from the rinsed bags. Thus, it was determined to be unlikely that substantial levels of enrichment nutrients remain in the rice bags.

Statistical Analysis

Analytical nutrient values from the laboratories were received electronically as Excel spreadsheets (Excel version 2003, Microsoft Inc, Redmond,WA) and combined into a single spreadsheet for statistical analyses. For each enrichment nutrient in each of the 11 rice samples labeled as enriched, a t test was performed in Excel to determine if the analytical value for the sample was statistically different ($P<0.05$) from the minimum enrichment standard for rice (2) (converted to a 100-g basis) and from the unenriched rice value (average of seven samples). Variability for these tests was computed from the variability among samples within nutrient. Because the variability among samples should exceed the variability within a sample, this assumption leads to a conservative test for statistically significant differences.

RESULTS

Enrichment Labeling of Rice Bags in Stores

The rice available in stores on the three islands revealed differences in the enrichment labeling of rice bags (Table 2). Of the largest bags (20 to 50 lb), none from Hawaii and only three from Saipan were labeled as enriched. However, most of the smaller bags of rice (2 to 10 lb) in these two locations were labeled as enriched. Enrichment labeling also tended to vary by type of rice, with Calrose rice less likely to be labeled as enriched than long-grain

Table 2. The observed frequency and availability of different brands of white rice by bag size found in Hawaii, Guam, and Saipan

Location	Different Brands[a] 2-3 lb	5-10 lb	20-50 lb	Labeled "Enriched" 2-3 lb	5-10 lb	20-50 lb
	← n →			← n (%) →		
Honolulu, Hawaii[b]						
Long-grain	3	4	0	3 (100)	4 (100)	—
Medium-grain	4	2	8	1 (25)	0	0
Calrose	1	5	6	0	1 (20)	0
Jasmine	1	4	4	0	0	0
Other[c]	3	3	2	1 (33)	1 (33)	0
Guam[d]						
Long-grain	0	0	1	—	—	1 (100)
Medium-grain	1	0	6	0	—	2 (33)
Calrose	0	2	5	—	2 (100)	5 (100)
Jasmine	0	1	8	—	0	6 (75)
Saipan[e]						
Long-grain	3	2	2	3 (100)	2 (100)	1 (50)
Medium-grain	3	1	2	1 (33)	0	0
Calrose	0	3	6	—	0	0
Jasmine	0	9	10	—	3 (33)	2 (20)
Other	4	4	3	2 (50)	0	0

[a]Each brand (within size) was counted once, even if found in multiple stores.
[b]Honolulu survey included one large discount store, three supermarkets, and one ethnic store.
[c]"Other" includes sweet, sushi, basmati, pearl, fragrant, and scented rice.
[d]Guam survey included two large discount stores, four supermarkets, and one ethnic store.
[e]Saipan survey included three large stores, two ethnic stores, and three small shops.

rice. In Guam, a majority of bags were labeled as enriched, regardless of size or type.

Nutrients in Rice from Hawaii, Guam, and Saipan

All samples were uncooked when analyzed. Nutrient values reported were 100-g raw, uncooked rice, which yields approximately 1 cup cooked rice. Average moisture content for the samples of uncooked rice (15 enriched and 7 unenriched) was 12.8 g/100 g. The nutrient values per 100 g for the seven unenriched rice samples were (mean mg/100 g$\pm$standard deviation): thiamin, 0.05$\pm$0.02; niacin, 1.22$\pm$0.34; and iron, 0.38$\pm$0.14. Because folic acid in unenriched rice is very low (<5 μg/100g) (6), it was not measured.

The Figure shows the results of the nutrient analyses of the 11 enriched rice samples collected in Honolulu and Guam. The minimum enrichment standards are based on the standard of identity for enriched rice in the Code of Federal Regulations, Title 21, Part 137.350 (2). On a 100-g basis, the minimum levels are 0.44 mg for thiamin, 3.5 mg for niacin, 154 μg for folic acid, and 2.9 mg for iron.

Sample L, the 12th enriched rice sample, was from Saipan and was the only sample with values that exceeded the minimum enrichment standards for iron, thiamin, and niacin (folic acid analyses were not performed for this sample). To avoid distorting the scale, it is not shown in the Figure, but the nutrient values are given in a footnote. Values for all other samples (A through K) were significantly below the standard ($P<0.05$), except samples A, J, and K for thiamin, samples E, G, I, J, and K for niacin, and sample J for iron. All five samples analyzed for folic acid yielded values significantly below the minimum enrichment standard. Among the 11 samples from Hawaii and Guam that were labeled as enriched, only sample J did not fall substantially below the minimum enrichment levels for all three nutrients (thiamin, niacin, and iron).

Nutrients in Rice from California

All three packages of rice that were purchased in California were labeled enriched, and values for three of the enrichment nutrients exceeded the minimum enrichment standards. For samples M, N, and O, respectively, thiamin content was 0.65, 1.76, and 0.74 mg/100 g, niacin content was 5.78, 19.50, and 7.80 mg/100 g, and iron content was 3.01, 15.50, and 3.63 mg/100 g. The nutrients in sample N, a Calrose rice, greatly exceeded the maximum levels in the Code of Federal Regulations by 0.88 mg/100 g over the maximum for thiamin, 7.0 mg/100 g over the maximum for niacin, and 5.8 mg/100 g over the maximum for iron. Sample M was from a package that was identical to sample L from Saipan, but the enrichment nutrients still varied: the thiamin level was 0.65 mg/100 g in the California sample and 1.36 mg/100 g in the Saipan sample; niacin values were 5.78 and 6.37 mg/100 g, respectively, while iron values were 3.01 and 3.50 mg/100 g. Similarly, sample O from California was from a package that was the same as that for sample K from Honolulu, but the levels of enrichment were over twice as high in the California sample.

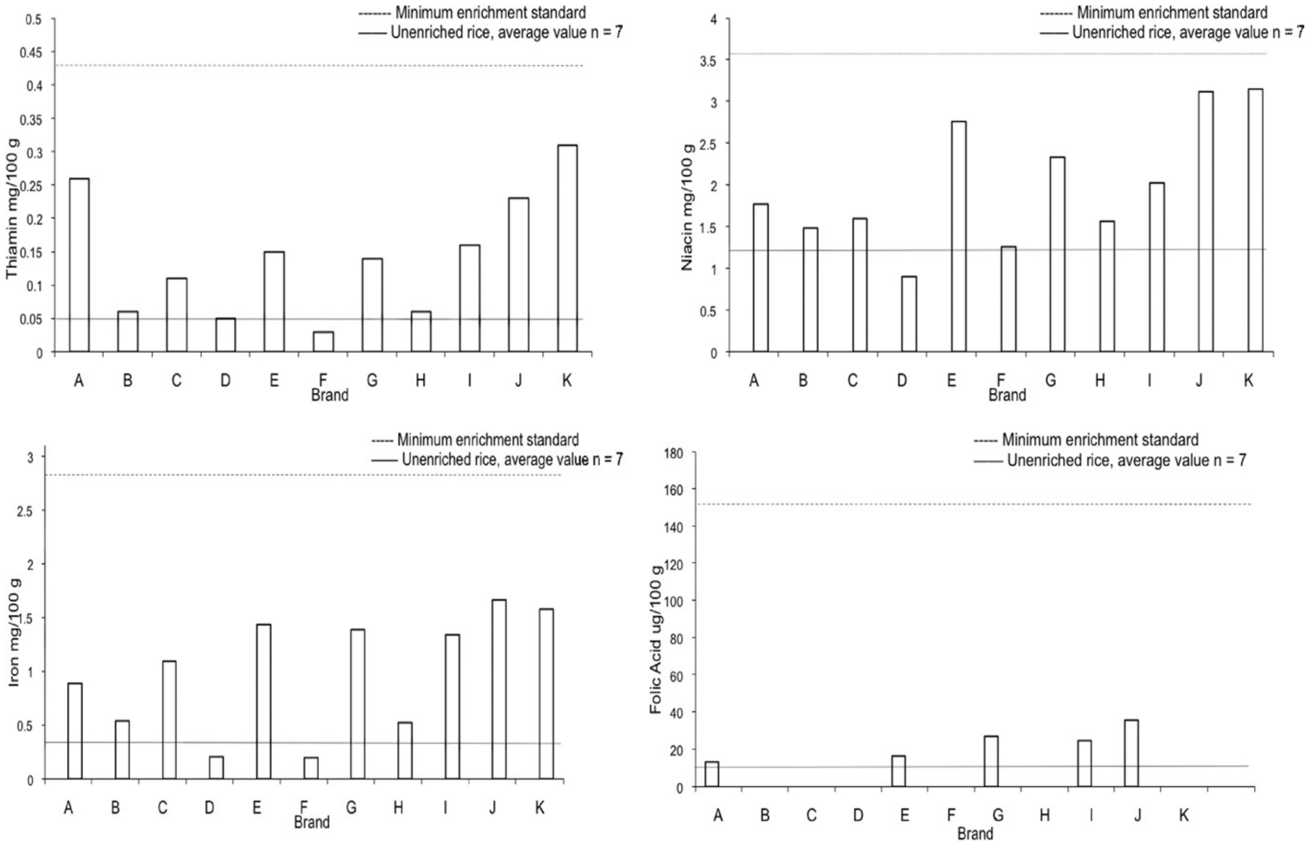

Figure. Analytical values (per 100 g) for thiamin, niacin, iron, and folic acid in 11 samples of rice labeled "enriched" collected from Honolulu, Hawaii (rice brands A, B, C, and K) and Guam (rice brands D, E, F, G, H, I, and J) compared to minimum enrichment standards (from the US Food and Drug Administration [2], and average values for unenriched rice (average nutrient level in seven samples of unenriched rice). To preserve the scale, analytical values for sample L (from Saipan) are not included in the Figure: thiamin=1.36 mg/100 g; niacin=6.37 mg/100 g; and iron=3.5 mg/100 g. Because of limited funding, folic acid was not analyzed in all samples.

DISCUSSION

Findings suggest that most rice in these islands was not enriched at the time of this study, even when labeled as enriched. In Hawaii and Saipan, very few of the commonly purchased larger bags were labeled as enriched. In Guam, the larger bags were frequently labeled as enriched, but analyses show that the levels of the four enrichment nutrients were usually well below the minimum standards. All three locations are US-affiliated, so food labels are under Food and Drug Administration jurisdiction. These data have been provided to the Food and Drug Administration for follow-up.

Consumption of enriched rice that is not actually enriched is cause for concern by public health professionals in these locations. Intakes of thiamin, niacin, iron, and folate are probably lower than has been previously estimated because food-consumption surveys have generally used food-composition values for enriched rice. The Food and Nutrient Database for Dietary Surveys, which is used for US national nutrition surveys, assumes enrichment of all white rice except Thai "sticky" rice (15). Furthermore, institutional feeding programs, such as the School Lunch Program in Guam, Saipan, and Hawaii, may also be unknowingly serving unenriched rice to their participants, and thus not delivering the assumed level of enrichment nutrients. Because rice is a primary staple food on these islands, the prevalence of nutrient inadequacy may be undesirably higher than that of the general US population. It would be useful to reevaluate estimated nutrient intakes from US dietary surveys under the assumption that white rice is unenriched. In addition, washing rice is a common practice among many Asian and Pacific cultures, despite package directions to the contrary. This would further remove enrichment nutrients in white rice.

There is no explanation for the low levels of enrichment nutrients in rice that is labeled as enriched in Guam and Hawaii. Although the labels do not indicate how the enrichment is performed, ie, powder dusting or liquid coating, current regulations require the following statement for powder enrichment: "To retain vitamins do not rinse before or drain after cooking." Five of the 12 bags of enriched rice from the islands bore that statement. One bag labeled as enriched stated "washing not necessary." Another one of the enriched bags included as part of the cooking directions, "wash under cold running water." Of the three bags from California, two gave the required statement for powder enrichment and the third said that washing was not necessary. Thus, it seems likely that powdered enrichment was more commonly the process used for the analyzed rice in this study.

There was no indication that iron enrichment particles were left in the packaging. If coating-type enrichment was used, then it might result in low enrichment values if the sample did not include enough of the liquid-coated rice kernels. However, little variation was found across multiple samples from a single bag, indicating that the contents were relatively uniform. A more complete investigation of the types of enrichment that are commonly used for rice and reasons for the low levels that were found was beyond the resources available for the current study.

CONCLUSIONS

This is one of the first studies to examine rice enrichment in these three Pacific island locations. Results demonstrated that dietary intake estimates of thiamin, niacin, iron, and folate for people consuming substantial amounts of rice in these Pacific Islands may be inaccurate. Food-composition tables generally do not contain nutrient values for location, brand, type of rice, and package size and there was considerable enrichment level variability by these variables. Entries on the National Nutrient Database for Standard Reference are often representative averages of analytic values from food items obtained in multiple locations in the United States (5). However, it may be important to increase the specificity of the entries to include different representative values for different locations (such as California vs the Pacific islands). It may also be useful to ask survey participants for information on the brand, type, and package size of rice that is typically purchased and consumed. Until better data are available, registered dietitians, food and nutrition professionals, and others who plan or evaluate the diets of these Pacific Island populations should not assume that rice is enriched, even when it is so labeled.

Because these data are based on a convenience sample, the true prevalence of low rice enrichment levels for this region is not known. Rice is a staple food for many cultures in this area and nutrients delivered through rice enrichment are of public health importance. Given the results presented in this article, a comprehensive sampling and nutrient analysis of enriched rice in the Pacific Islands is warranted to determine the true extent of the problem.

STATEMENT OF POTENTIAL CONFLICT OF INTEREST: No potential conflict of interest was reported by the authors.

FUNDING/SUPPORT: This study was funded by a National Cancer Institute Minority Institute/Cancer Research Center Partnership Grant #1056-CA-096278-01A1 and Agriculural Research Service/US Department of Agriculture.

References

1. Institute of Medicine, Food and Nutrition Board. *Dietary Reference Intakes: Guiding Principles for Nutrition Labeling and Fortification*. Washington, DC: National Academies Press; 2003.
2. US Food and Drug Administration, Department of Health and Human Services: Enriched Rice. *Code of Federal Regulations, Title 21, Pt. 137.350*. US Government Printing, 2008. http://edocket.access.gpo.gov/cfr_2008/aprqtr/pdf/21cfr137.350.pdf. Accessed December 23, 2008.
3. Leon Guerrero RT, Paulino YC, Novotny R, Murphy SP. Diet and obesity among Chamorro and Filipino adults on Guam. *Asia Pac J Clin Nutr*. 2008;17:216-222.
4. Kolonel LN, Henderson BE, Hankin JH, Nomura AMY, Wilkens LR, Pike MC, Stram DO, Monroe DR, Earle ME, Nagamine FS. A multiethnic cohort in Hawaii and Los Angeles: Baseline characteristics. *Am J Epidemiol*. 2000;151:346-357.
5. Pehrsson PR, Haytowitz DB, Holden JM, Perry CR. USDA's National food and nutrient analysis program: Food sampling. *J Food Comp Anal*. 2000;13:379-389.
6. Wright JD, Wang C-Y, Kennedy-Stephenson J, Ervin RB. Dietary intake of ten key nutrients for public health, United States: 1999-2000. *Advance Data from Vital and Health Statistics, No. 334*. Hyattsville MD: National Center for Health Statistics; 2003.
7. Alavi S, Bugusu B, Cramer G, Dary O, Lee TC, Martin L, McEntire J, Wailes E, eds. Rice Fortification in Developing Countries: A Critical Review of the Technical and Economic Feasibility. Washington, DC: A2Z Project, Academy for Educational Development; April 2008. http://www.a2zproject.org. Accessed July 29, 2008.
8. Dexter PB. Rice Fortification For Developing Countries. Fayetteville, AR: OMNI/USAID; August 1998. http://www.mostproject.org/PDF/rice4.pdf. Accessed July, 29, 2008.
9. Hoffpauer DW. Enrichment and fortification of rice. In: Champagne ET, ed. *Rice: Chemistry and Technology*. St Paul, MN: American Association of Cereal Chemists; 2004:405-414.
10. Pehrsson PR, Haytowitz DB, Holden JM. The USDA's National Food and Nutrient Analysis Program: Update 2002. *J Food Comp Anal*. 2003;16:331-341.
11. Phillips KM, Wolf WR, Patterson KY, Sharpless KE, Amanna KR, Holden JM. Summary of reference materials for the determination of the nutrient composition of foods. *Accred Qual Assur*. 2007;12:126-133.
12. Association of Official Analytical Chemists. *Official Methods of Analysis*. 17th ed, 2nd revision. Gaithersburg, MD: AOAC International; 2004.
13. Doherty RF, Beecher GR. A method for the analysis of natural and synthetic folate in foods. *J Agric Food Chem*. 2003;51:354-361.
14. Kok RM, Smith DEC, Dainty JR, van der Akker JT, Finglas PM, Smulders YM, Jakobs C, de Meer K. 5-Methyltetrahydrofolic and folic acid measured in plasma with liquid chromatography tandem mass spectrometry: Application to folate absorption and metabolism. *Anal Biochem*. 2004;326:129-138.
15. US Department of Agriculture, Agricultural Research Service. What's In the Foods You Eat Search Tool, 3.0. http://www.ars.usda.gov/foodsearch. Accessed July 27, 2008.